

Appendix B-1

**Simply supported square plate. 1/4 sym. Plate overall dimensions 2" X 2"
QUAD4 is MIN4T element**

Plate thickness 0.02" (thin)

Table B1-1

Convergence study - increasing mesh size
Thin plate: 0.02" using MIN4T quad elements
Uniform pressure load 0.05 psi

Central point lateral displacement: theoretical = 4.070E-04 inches

Mesh	QUAD4 (MIM4) (AQ3U1Sxxx)	TRIA3 (AT3U1Sxxx)	QUAD4K (AQ2U1Sxxx)	TRIA3K (AT2U1Sxxx)
2	4.177474E-04	3.882019E-04	4.053825E-04	4.064101E-04
5	4.089617E-04	4.044364E-04	4.069221E-04	4.072906E-04
10	4.076979E-04	4.066298E-04	4.070296E-04	4.071537E-04
20	4.073804E-04	4.071399E-04	4.070529E-04	4.070879E-04
50	4.072894E-04	4.072582E-04	4.070591E-04	4.070651E-04
100	4.072759E-04	4.072688E-04	4.070600E-04	4.070615E-04
200		4.072707E-04	4.070602E-04	4.070605E-04

Max M_x or M_y bending moment: theoretical = 9.577E-03 lb-in/in

Mesh	QUAD4 (MIN4) (AQ3U1Sxxx)	TRIA3 (AT3U1Sxxx)	QUAD4K (AQ2U1Sxxx)	TRIA3K (AT2U1Sxxx)
2	-8.041848E-03	-8.251984E-03	-7.932362E-03	-7.980317E-03
5	-9.329311E-03	-9.402860E-03	-9.316309E-03	-9.326607E-03
10	-9.516958E-03	-9.538238E-03	-9.513549E-03	-9.514432E-03
20	-9.563905E-03	-9.568613E-03	-9.562834E-03	-9.562405E-03
50	-9.576865E-03	-9.577013E-03	-9.576632E-03	-9.576411E-03
100	-9.578667E-03	-9.578567E-03	-9.578603E-03	-9.578518E-03
200		-9.579062E-03	-9.579095E-03	-9.579065E-03

Max M_{xy} twisting moment: theoretical = -6.496E-03 lb-in/in

Mesh	QUAD4 (MIN4) (AQ3U1Sxxx)	TRIA3 (AT3U1Sxxx)	QUAD4K (AQ2U1Sxxx)	TRIA3K (AT2U1Sxxx)
2	-4.642756E-03	-4.423924E-03	-4.823450E-03	-4.763773E-03
5	-6.039231E-03	-6.069230E-03	-6.075395E-03	-6.067006E-03
10	-6.350917E-03	-6.381598E-03	-6.360069E-03	-6.360019E-03
20	-6.451331E-03	-6.466028E-03	-6.453200E-03	-6.454149E-03
50	-6.485836E-03	-6.489589E-03	-6.485967E-03	-6.486422E-03
100	-6.491724E-03	-6.492906E-03	-6.491745E-03	-6.491934E-03
200		-6.493751E-03	-6.493411E-03	-6.493480E-03

Max V_x or V_y transverse shear force: theoretical = -3.375E-02 lb/in

Mesh	QUAD4 (MIN4) (AQ3U1Sxxx)	TRIA3 (AT3U1Sxxx)
2	-2.120397E-02	-2.355221E-02
5	-2.873378E-02	-2.980993E-02
10	-3.125650E-02	-3.210377E-02
20	-3.251324E-02	-3.310807E-02
50	-3.326562E-02	-3.343383E-02
100	-3.351608E-02	-3.356282E-02
200		-3.366052E-02

Table B1-2

**Random disorder of element shape - mesh size is 10 x 10
Thin plate: 0.02" using MIN4T quad elements
Uniform pressure load 0.05 psi**

Central point lateral displacement: theoretical = 4.070E-04 inches

Random Grid Disprder	QUAD4 (MIN4) (AQ3R1S010)	TRIA3 (AT3R1S010)	QUAD4K (AQ2R1S010)	TRIA3K (AT2R1S010)
.0	4.076979E-04	4.066298E-04	4.070296E-04	4.071537E-04
.1	4.076845E-04	4.065895E-04	4.069936E-04	4.070827E-04
.2	4.076601E-04	4.065019E-04	4.069458E-04	4.069921E-04
.3	4.076150E-04	4.063725E-04	4.068937E-04	4.069003E-04
.4	4.075636E-04	4.062242E-04	4.068626E-04	4.067432E-04
.5	4.075042E-04	4.059689E-04	4.067344E-04	4.066651E-04
.6	4.074408E-04	4.053971E-04	4.066827E-04	4.066200E-04
.7	See Note 1	4.052982E-04	See Note 1	4.063957E-04
.8	See Note 1	4.046979E-04	See Note 1	4.062411E-04

Max M_x or M_y bending moment: theoretical = 9.577E-03 lb-in/in

Random Grid Disprder	QUAD4 (MIN4) (AQ3R1S010)	TRIA3 (AT3R1S010)	QUAD4K (AQ2R1S010)	TRIA3K (AT2R1S010)
.0	-9.516958E-03	-9.538238E-03	-9.513549E-03	-9.514432E-03
.1	-9.508684E-03	-9.531171E-03	-9.511662E-03	-9.508362E-03
.2	-9.513518E-03	-9.540563E-03	-9.497620E-03	-9.497151E-03
.3	-9.498255E-03	-9.528532E-03	-9.509454E-03	-9.505900E-03
.4	-9.508094E-03	-9.518584E-03	-9.488904E-03	-9.480915E-03
.5	-9.475692E-03	-9.503319E-03	-9.471925E-03	-9.481681E-03
.6	-9.510552E-03	-9.467728E-03	-9.462858E-03	-9.453775E-03
.7	See Note 1	-9.503531E-03	See Note 1	-9.486368E-03
.8	See Note 1	-9.454101E-03	See Note 1	-9.485915E-03

Max M_{xy} twisting moment: theoretical = -6.496E-03 lb-in/in

Random Grid Disprder	QUAD4 (MIN4) (AQ3R1S010)	TRIA3 (AT3R1S010)	QUAD4K (AQ2R1S010)	TRIA3K (AT2R1S010)
.0	-6.350917E-03	-6.381598E-03	-6.360069E-03	-6.360019E-03
.1	-6.355576E-03	-6.378455E-03	-6.361073E-03	-6.361410E-03
.2	-6.350873E-03	-6.390043E-03	-6.370030E-03	-6.377284E-03
.3	-6.308518E-03	-6.420099E-03	-6.359695E-03	-6.375967E-03
.4	-6.350845E-03	-6.463871E-03	-6.340293E-03	-6.381823E-03
.5	-6.370382E-03	-6.409916E-03	-6.366337E-03	-6.401488E-03
.6	-6.220156E-03	-6.496164E-03	-6.357278E-03	-6.390720E-03
.7	See Note 1	-6.462622E-03	See Note 1	-6.371801E-03
.8	See Note 1	-6.719344E-03	See Note 1	-6.332287E-03

Max V_x or V_y transverse shear force: theoretical = -3.375E-02 lb/in

Random Grid Disprder	QUAD4 (MIN4) (AQ2R1S010)	TRIA3 (AT3R1S010)
.0	-3.125650E-02	-3.230785E-02
.1	-3.137727E-02	-3.249074E-02
.2	-3.131193E-02	-3.328399E-02
.3	-3.227968E-02	-3.352161E-02
.4	-3.253596E-02	-3.592427E-02
.5	-3.573537E-02	-3.431050E-02
.6	-3.739516E-02	-3.296402E-02
.7	See Note 1	-3.407969E-02
.8	See Note 1	-3.609102E-02

Note 1: Random disorder of internal grids is so large as to cause one or more elements to have a fatal error (e.g. interior angle > 180 deg, element not numbered CW or CCW, or negative area)

Appendix B-2

**Simply supported square plate. 1/4 sym. Plate overall dimensions 2" X 2"
QUAD4 is MIN4T element**

Plate thickness 0.20" (thick)

Table B2-1

Convergence study - increasing mesh size
Thick plate: 0.20" using MIN4T quad elements
Uniform pressure load 0.05 psi

Central point lateral displacement: theoretical = 4.294-07 in

Mesh	QUAD4 (MIM4) (AQ3US2xxx)	TRIA3 (AT3US2xxx)	QUAD4K (AQ2US2xxx)	TRIA3K (AT2US2xxx)
2	4.395387E-07	4.146006E-07	4.053825E-04	4.064101E-07
5	4.300534E-07	4.270713E-07	4.069221E-04	4.072906E-07
10	4.286389E-07	4.280076E-07	4.070296E-04	4.071537E-07
20	4.282798E-07	4.281360E-07	4.070529E-04	4.070879E-07
50	4.281788E-07	4.281575E-07	4.070591E-04	4.070651E-07
100	4.281643E-07	4.281593E-07	4.070600E-04	4.070615E-07
200		4.281595E-07	4.070602E-07	4.070606E-07

Max M_x or M_y bending moment: theoretical = 9.607E-03 lb-in/in

Mesh	QUAD4 (MIN4) (AQ3US2xxx)	TRIA3 (AT3US2xxx)	QUAD4K (AQ2US2xxx)	TRIA3K (AT2US2xxx)
2	-8.074155E-03	-8.286672E-03	-7.932362E-03	-7.980317E-03
5	-9.340636E-03	-9.384681E-03	-9.316309E-03	-9.326607E-03
10	-9.520004E-03	-9.522622E-03	-9.513549E-03	-9.514432E-03
20	-9.564479E-03	-9.562965E-03	-9.562834E-03	-9.562405E-03
50	-9.576896E-03	-9.576334E-03	-9.576632E-03	-9.576411E-03
100	-9.578669E-03	-9.578481E-03	-9.578603E-03	-9.578518E-03
200		-9.579054E-03	-9.579094E-03	-9.579056E-03

Max M_{xy} twisting moment: theoretical = -6.225E-03 lb-in/in

Mesh	QUAD4 (MIN4) (AQ3US2xxx)	TRIA3 (AT3US2xxx)	QUAD4K (AQ2US2xxx)	TRIA3K (AT2US2xxx)
2	-4.668448E-03	-4.500427E-03	-4.823450E-03	-4.763773E-03
5	-6.052187E-03	-6.089201E-03	-6.075395E-03	-6.067006E-03
10	-6.354222E-03	-6.379003E-03	-6.360069E-03	-6.360019E-03
20	-6.451367E-03	-6.461321E-03	-6.453200E-03	-6.454149E-03
50	-6.485563E-03	-6.487857E-03	-6.485967E-03	-6.486422E-03
100	-6.491641E-03	-6.492338E-03	-6.491745E-03	-6.491934E-03
200		-6.493610E-03	-6.493411E-03	-6.493481E-03

Max V_x or V_y transverse shear force: theoretical = -3.374E-02 lb/in

Mesh	QUAD4 (MIN4) (AQ3US2xxx)	TRIA3 (AT3US2xxx)
2	-2.112100E-02	-2.338886E-02
5	-2.870941E-02	-2.916144E-02
10	-3.125004E-02	-3.133337E-02
20	-3.251203E-02	-3.252939E-02
50	-3.326553E-02	-3.327051E-02
100	-3.351604E-02	-3.351810E-02
200		-3.364134E-02

Table B2-2

Random disorder of element shape - mesh size is 10 x 10
Thick plate: 0.20" using MIN4T quad elements
Uniform pressure load 0.05 psi

Central point lateral displacement: theoretical = 4.294E-07 in

Random Grid Disprder	QUAD4 (MIN4) (AQ3R2S010)	TRIA3 (AT3R2S010)	QUAD4K (AQ2R2S010)	TRIA3K (AR2R2S010)
.0	4.286389E-07	4.280076E-07	4.070296E-04	4.071537E-07
.1	4.286363E-07	4.279977E-07	4.069889E-07	4.070835E-07
.2	4.286255E-07	4.279538E-07	4.069567E-07	4.069980E-07
.3	4.286026E-07	4.278728E-07	4.069297E-07	4.069015E-07
.4	4.285964E-07	4.277729E-07	4.068571E-07	4.067849E-07
.5	4.285648E-07	4.277427E-07	4.066887E-07	4.067714E-07
.6	4.285039E-07	4.274602E-07	See Note 1	4.066252E-07
.7	4.284351E-07	4.272412E-07	4.063414E-07	4.063621E-07
.8	See Note 1	4.273250E-07	See Note 1	4.062954E-07

Max M_x or M_y bending moment: theoretical = 9.607E-03 lb-in/in

Random Grid Disprder	QUAD4 (MIN4) (AQ3R2S010)	TRIA3 (AT3R2S010)	QUAD4K (AQ2R2S010)	TRIA3K (AT2R2S010)
.0	-9.520004E-03	-9.522622E-03	-9.513549E-03	-9.514432E-03
.1	-9.516887E-03	-9.516944E-03	-9.508573E-03	-9.509657E-03
.2	-9.515005E-03	-9.513496E-03	-9.500159E-03	-9.497733E-03
.3	-9.510936E-03	-9.510518E-03	-9.497190E-03	-9.498315E-03
.4	-9.503080E-03	-9.502445E-03	-9.492558E-03	-9.484133E-03
.5	-9.495133E-03	-9.499946E-03	-9.468693E-03	-9.478471E-03
.6	-9.485838E-03	-9.482645E-03	See Note 1	-9.475569E-03
.7	-9.523367E-03	-9.482962E-03	-9.479518E-03	-9.450705E-03
.8	See Note 1	-9.488444E-03	See Note 1	-9.472364E-03

Max M_{xy} twisting moment: theoretical = -6.225E-03 lb-in/in

Random Grid Disprder	QUAD4 (MIN4) (AQ3R2S010)	TRIA3 (AT3R2S010)	QUAD4K (AQ2R2S010)	TRIA3K (AT2R2S010)
.0	-6.354222E-03	-6.379003E-03	-6.360069E-03	-6.360019E-03
.1	-6.358936E-03	-6.386316E-03	-6.363487E-03	-6.360086E-03
.2	-6.377200E-03	-6.398629E-03	-6.367205E-03	-6.367530E-03
.3	-6.335701E-03	-6.390431E-03	-6.347635E-03	-6.389979E-03
.4	-6.359404E-03	-6.433151E-03	-6.361833E-03	-6.356812E-03
.5	-6.337010E-03	-6.424353E-03	-6.375497E-03	-6.376842E-03
.6	-6.323262E-03	-6.421069E-03	See Note 1	-6.386909E-03
.7	-6.361620E-03	-6.419936E-03	-6.329188E-03	-6.416808E-03
.8	See Note 1	-6.458207E-03	See Note 1	-6.414755E-03

Max V_x or V_y transverse shear force: theoretical = -3.374E-02 lb/in

Random Grid Disprder	QUAD4 (MIN4) (AQ3R2S010)	TRIA3 (AT3R2S010)
.0	-3.125004E-02	-3.133337E-02
.1	-3.131184E-02	-3.132976E-02
.2	-3.129734E-02	-3.136309E-02
.3	-3.129752E-02	-3.139836E-02
.4	-3.133671E-02	-3.125302E-02
.5	-3.128780E-02	-3.130338E-02
.6	-3.120514E-02	-3.098793E-02
.7	-3.094243E-02	-3.154259E-02
.8	See Note 1	-3.127497E-02

Note 1: Random disorder of internal grids is so large as to cause one or more elements to have a fatal error (e.g. interior angle > 180 deg, element not numbered CW or CCW, or negative area)

Appendix B-3

Square plate supported only at the central point. 1/4 sym.

Plate overall dimensions 2" X 2"

QUAD4 is MIN4T element

Plate thickness 0.02" (thin)

Table B3-1

Convergence study - increasing mesh size
Thin plate: 0.02” using MIN4T quad elements
Stress free thermal expansion – 1.0 deg bulk temperature change

Central point lateral displacement: theoretical = 2.E-05 in

Mesh	QUAD4 (MIM4T) (BQ3U1Fxxx)	TRIA3 (BT3U1Fxxx)	QUAD4K (BQ2U1Fxxx)	TRIA3K (BT2U1Fxxx)
2	2.000000E-05	2.000000E-05	2.000000E-05	2.000000E-05
5	2.000000E-05	2.000000E-05	2.000000E-05	2.000000E-05
10	2.000000E-05	2.000000E-05	2.000000E-05	2.000000E-05
20	2.000000E-05	2.000000E-05	2.000000E-05	2.000000E-05
50	2.000000E-05	2.000000E-05	2.000000E-05	2.000000E-05
100	2.000000E-05	2.000000E-05	2.000000E-05	2.000000E-05
200		2.000000E-05	2.000000E-05	2.000000E-05

Max stress: theoretical = 0 lb/in²

Mesh	QUAD4 (MIN4T) (BQ3U1Fxxx)	TRIA3 (BT3U1Fxxx)	QUAD4K (BQ2U1Fxxx)	TRIA3K (BT2U1Fxxx)
2	E-13	E-13	E-13	E-13
5	E-13	E-12	E-12	E-12
10	E-12	E-12	E-12	E-12
20	E-12	E-12	E-12	E-12
50	E-11	E-11	E-11	E-11
100	E-10	E-10	E-10	E-10
200		E-10	E-09	E-10

Table B3-2

Random disorder of element shape - mesh size is 10 x 10
Thin plate: 0.02" using MIN4T quad elements
Stress free thermal expansion – 1.0 deg bulk temperature change

Central point lateral displacement: theoretical = 2.E-05 in

Random Grid Disprder	QUAD4 (MIN4) (BQ3R1F010)	TRIA3 (BT3R1F010)	QUAD4K (BQ2R1F010)	TRIA3K (BT2R1F010)
.0	2.000000E-05	2.000000E-05	2.000000E-05	2.000000E-05
.1	2.000000E-05	2.000000E-05	2.000000E-05	2.000000E-05
.2	2.000000E-05	2.000000E-05	2.000000E-05	2.000000E-05
.3	2.000000E-05	2.000000E-05	2.000000E-05	2.000000E-05
.4	2.000000E-05	2.000000E-05	2.000000E-05	2.000000E-05
.5	2.000000E-05	2.000000E-05	2.000000E-05	2.000000E-05
.6	2.000000E-05	2.000000E-05	2.000000E-05	2.000000E-05
.7	2.000000E-05	2.000000E-05	See Note 1	2.000000E-05
.8	See Note 1	2.000000E-05	See Note 1	2.000000E-05

Max stress: theoretical = 0 lb/in²

Random Grid Disprder	QUAD4 (MIN4) (BQ3R1F010)	TRIA3 (BT3R1F010)	QUAD4K (BQ2R1F010)	TRIA3K (BT2R1F010)
.0	E-12	E-12	E-12	E-12
.1	E-12	E-12	E-12	E-12
.2	E-12	E-12	E-12	E-12
.3	E-12	E-12	E-12	E-12
.4	E-12	E-12	E-12	E-12
.5	E-12	E-12	E-12	E-12
.6	E-12	E-12	E-11	E-12
.7	E-12	E-12	See Note 1	E-12
.8	See Note 1	E-12	See Note 1	E-11

Note 1: Random disorder of internal grids is so large as to cause one or more elements to have a fatal error (e.g. interior angle > 180 deg, element not numbered CW or CCW, or negative area)

Table B3-3

Convergence study - increasing mesh size
Thin plate: 0.02” using MIN4T quad elements
Stress free thermal expansion – 1.0- deg temperature gradient through thickness

Central point lateral displacement: theoretical = -2.E-05 in

Mesh	QUAD4 (MIN4T) (BQ3U1Fxxx)	TRIA3 (BT3U1Fxxx)	QUAD4K (BQ2U1Fxxx)	TRIA3K (BT2U1Fxxx)
2	-2.000000E-05	-2.000000E-05	-2.000000E-05	-2.000000E-05
5	-2.000000E-05	-2.000000E-05	-2.000000E-05	-2.000000E-05
10	-2.000000E-05	-2.000000E-05	-2.000000E-05	-2.000000E-05
20	-2.000000E-05	-2.000000E-05	-2.000000E-05	-2.000000E-05
50	-2.000000E-05	-2.000000E-05	-2.000000E-05	-2.000000E-05
100	-2.000000E-05	-2.000000E-05	-2.000000E-05	-2.000000E-05
200		-2.000000E-05	-2.000000E-05	-1.999998E-05

Max stress: theoretical = 0 lb/in²

Mesh	QUAD4 (MIN4T) (BQ3U1Fxxx)	TRIA3 (BT3U1Fxxx)	QUAD4K (BQ2U1Fxxx)	TRIA3K (BT2U1Fxxx)
2	E-13	E-13	E-14	E-14
5	E-12	E-12	E-12	E-13
10	E-11	E-11	E-11	E-12
20	E-10	E-11	E-09	E-09
50	E-09	E-08	E-08	E-08
100	E-07	E-09	E-08	E-06
200		E-08	E-06	E-05

Table B3-4**Random disorder of element shape - mesh size is 10 x 10****Thin plate: 0.02" using MIN4T quad elements****Stress free thermal expansion – 1.0 deg temperature gradient through thickness****Central point lateral displacement: theoretical = -2.E-05 in**

Random Grid Disprder	QUAD4 (MIN4T) (BQ3R1F010)	TRIA3 (BT3R1F010)	QUAD4K (BQ2R1F010)	TRIA3K (BT2R1F010)
.0	-2.000000E-05	-2.000000E-05	-2.000000E-05	-2.000000E-05
.1	-2.000000E-05	-2.000000E-05	-2.000000E-05	-2.000000E-05
.2	-2.000000E-05	-2.000000E-05	-2.000000E-05	-2.000000E-05
.3	-2.000000E-05	-2.000000E-05	-2.000000E-05	-2.000000E-05
.4	-2.000000E-05	-2.000000E-05	-2.000000E-05	-2.000000E-05
.5	-2.000000E-05	-2.000000E-05	-2.000000E-05	-2.000000E-05
.6	-2.000000E-05	-2.000000E-05	-2.000000E-05	-2.000000E-05
.7	-2.000000E-05	-2.000000E-05	See Note 1	-2.000000E-05
.8	See Note 1	-2.000000E-05	See Note 1	-1.998677E-05

Max stress: theoretical = 0 lb/in²

Random Grid Disprder	QUAD4 (MIN4T) (BQ3R1F010)	TRIA3 (BT3R1F010)	QUAD4K (BQ2R1F010)	TRIA3K (BT2R1F010)
.0	E-11	E-11	E-11	E-12
.1	E-12	E-11	E-11	E-11
.2	E-12	E-11	E-11	E-11
.3	E-11	E-11	E-11	E-11
.4	E-11	E-11	E-11	E-12
.5	E-11	E-11	E-11	E-11
.6	E-10	E-11	E-11	E-11
.7	E-11	E-11	See Note 1	E-11
.8	See Note 1	E-11	See Note 1	E-02

Note 1: Random disorder of internal grids is so large as to cause one or more elements to have a fatal error (e.g. interior angle > 180 deg, element not numbered CW or CCW, or negative area)

Appendix B-4

Square plate supported only at the central point. 1/4 sym.

Plate overall dimensions 2" X 2"

QUAD4 is MIN4T element

Plate thickness 0.20" (thick)

Table B4-1

Convergence study - increasing mesh size
Thick plate: 0.20" using MIN4T quad elements
Stress free thermal expansion – 1.0 deg bulk temperature change

Central point lateral displacement: theoretical = 2.E-05 in

Mesh	QUAD4 (MIM4T) (BQ3U2Fxxx)	TRIA3 (BT3U2Fxxx)	QUAD4K (BQ2U2Fxxx)	TRIA3K (BT2U2Fxxx)
2	2.000000E-05	2.000000E-05	2.000000E-05	2.000000E-05
5	2.000000E-05	2.000000E-05	2.000000E-05	2.000000E-05
10	2.000000E-05	2.000000E-05	2.000000E-05	2.000000E-05
20	2.000000E-05	2.000000E-05	2.000000E-05	2.000000E-05
50	2.000000E-05	2.000000E-05	2.000000E-05	2.000000E-05
100	2.000000E-05	2.000000E-05	2.000000E-05	2.000000E-05
200		2.000000E-05	2.000000E-05	2.000000E-05

Max stress: theoretical = 0 lb/in²

Mesh	QUAD4 (MIN4T) (BQ3U2Fxxx)	TRIA3 (BT3U2Fxxx)	QUAD4K (BQ2U2Fxxx)	TRIA3K (BT2U2Fxxx)
2	E-13	E-13	E-13	E-13
5	E-12	E-12	E-12	E-12
10	E-11	E-12	E-12	E-12
20	E-11	E-11	E-12	E-11
50	E-10	E-10	E-10	E-10
100	E-10	E-10	E-10	E-10
200		E-09	E-09	E-09

Table B4-2

Random disorder of element shape - mesh size is 10 x 10
Thick plate: 0.20" using MIN4T quad elements
Stress free thermal expansion – 1.0 deg bulk temperature change

Central point lateral displacement: theoretical = 2.E-05 in

Random Grid Disprder	QUAD4 (MIN4T) (BQ3R2F010)	TRIA3 (BT3R2F010)	QUAD4K (BQ2R2F010)	TRIA3K (BT2R2F010)
.0	2.000000E-05	2.000000E-05	2.000000E-05	2.000000E-05
.1	2.000000E-05	2.000000E-05	2.000000E-05	2.000000E-05
.2	2.000000E-05	2.000000E-05	2.000000E-05	2.000000E-05
.3	2.000000E-05	2.000000E-05	2.000000E-05	2.000000E-05
.4	2.000000E-05	2.000000E-05	2.000000E-05	2.000000E-05
.5	2.000000E-05	2.000000E-05	2.000000E-05	2.000000E-05
.6	2.000000E-05	2.000000E-05	2.000000E-05	2.000000E-05
.7	2.000000E-05	2.000000E-05	See Note 1	2.000000E-05
.8	See Note 1	2.000000E-05	See Note 1	2.000000E-05

Max stress: theoretical = 0 lb/in²

Random Grid Disprder	QUAD4 (MIN4T) (BQ3R2F010)	TRIA3 (BT3R2F010)	QUAD4K (BQ2R2F010)	TRIA3K (BT2R2F010)
.0	E-11	E-12	E-12	E-12
.1	E-12	E-12	E-12	E-12
.2	E-12	E-12	E-12	E-12
.3	E-12	E-12	E-12	E-12
.4	E-12	E-12	E-12	E-12
.5	E-12	E-12	E-12	E-12
.6	E-12	E-12	E-12	E-12
.7	E-12	E-12	See Note 1	E-12
.8	See Note 1	E-12	See Note 1	E-11

Note 1: Random disorder of internal grids is so large as to cause one or more elements to have a fatal error (e.g. interior angle > 180 deg, element not numbered CW or CCW, or negative area)

Table B4-3

Convergence study - increasing mesh size
Thick plate: 0.20" using MIN4T quad elements
Stress free thermal expansion – 1.0 deg temperature gradient through thickness

Central point lateral displacement: theoretical = -2.E-05 in

Mesh	QUAD4 (MIN4T) (BQ3U2Fxxx)	TRIA3 (BT3U2Fxxx)	QUAD4K (BQ2U2Fxxx)	TRIA3K (BT2U2Fxxx)
2	-2.000000E-05	-2.000000E-05	-2.000000E-05	-2.000000E-05
5	-2.000000E-05	-2.000000E-05	-2.000000E-05	-2.000000E-05
10	-2.000000E-05	-2.000000E-05	-2.000000E-05	-2.000000E-05
20	-2.000000E-05	-2.000000E-05	-2.000000E-05	-2.000000E-05
50	-2.000000E-05	-2.000000E-05	-2.000000E-05	-2.000000E-05
100	-2.000000E-05	-2.000000E-05	-2.000000E-05	-2.000000E-05
200		-2.000000E-05	-2.000000E-05	-1.999998E-05

Max stress: theoretical = 0 lb/in²

Mesh	QUAD4 (MIN4T) (BQ3U2Fxxx)	TRIA3 (BT3U2Fxxx)	QUAD4K (BQ2U2Fxxx)	TRIA3K (BT2U2Fxxx)
2	E-12	E-13	E-13	E-13
5	E-12	E-12	E-11	E-11
10	E-11	E-11	E-10	E-11
20	E-11	E-10	E-09	E-09
50	E-10	E-10	E-07	E-07
100	E-10	E-10	E-06	E-06
200		E-09	E-04	E-05

Table B4-4

Random disorder of element shape - mesh size is 10 x 10
Thick plate: 0.20" using MIN4T quad elements
Stress free thermal expansion – 1.0 deg temperature gradient through thickness

Central point lateral displacement: theoretical = -2.E-05 in

Random Grid Disprder	QUAD4 (MIN4T) (BQ3R2F010)	TRIA3 (BT3R2F010)	QUAD4K (BQ2R2F010)	TRIA3K (BT2R2F010)
.0	-2.000000E-05	-2.000000E-05	-2.000000E-05	-2.000000E-05
.1	-2.000000E-05	-2.000000E-05	-2.000000E-05	-2.000000E-05
.2	-2.000000E-05	-2.000000E-05	-2.000000E-05	-2.000000E-05
.3	-2.000000E-05	-2.000000E-05	-2.000000E-05	-2.000000E-05
.4	-2.000000E-05	-2.000000E-05	-2.000000E-05	-2.000000E-05
.5	-2.000000E-05	-2.000000E-05	-2.000000E-05	-2.000000E-05
.6	-2.000000E-05	-2.000000E-05	-2.000000E-05	-2.000000E-05
.7	-2.000000E-05	-2.000000E-05	See Note 1	-2.000000E-05
.8	See Note 1	-2.000000E-05	See Note 1	-2.000000E-05

Max stress: theoretical = 0 lb/in²

Random Grid Disprder	QUAD4 (MIN4T) (BQ3R2F010)	TRIA3 (BT3R2F010)	QUAD4K (BQ2R2F010)	TRIA3K (BT2R2F010)
.0	E-11	E-11	E-10	E-11
.1	E-11	E-11	E-10	E-10
.2	E-11	E-11	E-10	E-10
.3	E-11	E-12	E-10	E-11
.4	E-11	E-12	E-10	E-10
.5	E-11	E-11	E-10	E-10
.6	E-11	E-11	E-10	E-10
.7	E-09	E-11	See Note 1	E-10
.8	See Note 1	E-11	See Note 1	E-10

Note 1: Random disorder of internal grids is so large as to cause one or more elements to have a fatal error (e.g. interior angle > 180 deg, element not numbered CW or CCW, or negative area)